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Evaluation of including ammonia dry deposition in backward Lagrangian stochastic modelling

Christoph Häni (1), Voglmeier Karl (2), Christof Ammann (2), and Thomas Kupper (1)

(1) Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences HAFL, Zollikofen, Switzerland,
(2) Agroscope Research Station, Climate and Agriculture, Zürich, Switzerland

Backward Lagrangian stochastic (bLS) dispersion modelling (Wilson et al., 2012) provides a convenient way to model the relation between the trace gas emission of a confined source area and the concentration measurement at a receptor some short distance (< 500 m) downwind of the emitting area. In general bLS models are not capable of simulating the reduction in the trace gas concentration due to the loss by the deposition pathway. Whereas the modelling of inert gases like methane (CH4) is not affected by deposition, gases with a high sorption capacity such as ammonia (NH3) that are readily deposited on any kind of surface will be prone to a bias in the emission estimation, if deposition is not included in the model. For short ranges between the source and the receptor, i.e. within the first few hundred meters, the removal of NH3 is largely dominated by dry deposition (Asman et al., 1998; Loubet et al., 2009).

We conducted 9 field experiments with an artificial source consisting of 36 individual orifices, from which we released a gas mixture consisting of 5% NH3 and 95% CH4. We had parallel measurements of the line-integrated NH3 and CH4 concentration at different locations and heights downwind of the source using open-path measuring systems (miniDOAS, Sintermann et al., 2016; GasFinder, Boreal Laser, Inc., Edmonton AB, Canada). The deposited fraction was calculated by a simple dry deposition algorithm that was included in the bLS model. The resulting average recovery rates were 1.10 for CH4 (standard error SE=0.022) and 0.69 (SE=0.018) for NH3 without accounting for deposition. The inclusion of the dry deposition pathway in the model was able to explain the systematically lower recovery rates observed for NH3.

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